

REMARKS

New claim 40 is supported throughout the original specification, and particularly at page 28, lines 18-21.

As a preliminary matter, the meaning of the expressions "sheet or film" and "film" and "suitable for molding" will be discussed.

None of the above terms can apply to moldings *per se*. The word "film" is defined extensively at page 86 of *Ullmann's Enc. of Ind. Chem.*, 5th Ed., vol. A11, 1988. It will be immediately apparent that films are, by nature, relatively thin, almost two-dimensional. The word "sheet" is defined at page 1313 of *Random House Dictionary of the English Language, Unabridged Edition*, 1983, as follows:

- Sheet...2. a broad, relatively thin, surface layer or covering.
- 3. a relatively thin, usually rectangular form, piece, plate or slab, as a photographic film, glass, metal, etc.
- 4. a material, as metal or glass, in the form of broad, relatively thin pieces. (Emphasis added.)

Note that from the foregoing definition, one can see that the word "sheet" is essentially synonymous with the word "film." The relationship of the two words as being virtual synonyms is further shown on pages 140 and 141 of *Roget's International Thesaurus*, 4th Ed., 1977, at item 227.2.

With respect to claim 40, the limitation "suitable for producing moldings" would not mean something already molded to one of ordinary skill in this art. Although one could say, in the broadest analysis, that it is possible to remold something that has

already been molded, that type of analysis is not appropriate in interpreting a patent claim, which should rather be interpreted in light of the disclosure and the ordinary meaning of the terms in the specific area of technology involved. *In re Watson*, 517 F.2d 465, 477, 186 USPQ 11, 20 (CCPA 1975), *In re Moore*, 439 F.2d 1232, 1235, 169 USPQ 236, 238 (CCPA 1971).

To whatever extent the examiner's rejection of the claims may depend on interpreting the claims as reading on already molded objects, it should be clear from the above description that the rejection is erroneous.

Referring to the final rejection, claims 27 and 32 have been rejected under 35 USC § 102 as being anticipated by Ellison. Claims 24-26, 29-31 and 34 have been rejected under 35 USC § 103 as being unpatentable over Ellison in view of Fischer. Claim 35 has been rejected under 35 USC § 103 as being unpatentable over Ellison in view of Fischer and Leca. These rejections are respectfully traversed.

The fundamental defect in all of the examiner's rejections based on Ellison has been pointed out in earlier responses by applicants. It should be emphasized that the claims prior to this amendment required extruded sheets or films. The claims do not read on films applied from solution. As now amended, and as explained above, even before this amendment, the claims do not and did not read on molded articles.

Applicants will not burden the record by reproducing the arguments presented in the unentered amendment filed on May 7, 2001. Instead, applicants merely request

that the examiner reconsider those arguments in view of the foregoing explanation of the necessary interpretation of the instant claims and with consideration given to the attached Declaration under 37 CFR § 1.132 of Dr. Grefenstein.

The Grefenstein declaration further explains applicants' previous arguments related to the use of the terms "oriented" and "non-oriented" to distinguish heat-shrinkable films which have been cold drawn or stretched from films that were not cold drawn. It explains the misleading use of the language "unoriented extruded film" in some prior art references, and why that misuse does not support the examiner's position with respect to the identity or similarity between the disclosures of the references relied on in the rejections and the instant claims.

With specific reference to the Fox patent, the comments presented in the unentered amendment are incorporated by reference here. With respect to the two additional patents referred to in the Advisory Action, the following comments are provided.

US 4,467,969 (Godfrey) relates to an on-line reclaim system. In the abstract in col. 2, lines 1-4, it is stated that oriented and unoriented film may be produced on an extrusion line. From the figure in the description in col. 4, line 50, to col. 5, line 12, it is evident that the film coming immediately from the extruder 10 and which is immersed in the cooling bath 11 is denoted as non-oriented, whereas the film is additionally oriented in oven 13 and delustering stand 14 and an annealing oven 16. Thus, again the terms

GREFENSTEIN et al., Serial No. 08/987,775

"oriented" and "unoriented" are only employed to distinguish drawn films and non-drawn films. The reference does not mean that extruded films *per se* are totally unoriented.

The same is true for US 4,420,451 (Rasmussen). This reference relates to a method for film extrusion comprising rotary die parts. In the abstract, it is noted that the extruded films are defined as molecularly unoriented except for the weak orientation produced by the melt-attenuation (and the extrusion) which is contrasted to the final strong biaxially orienting of a laminate by stretching in several steps. Thus, again the oriented film is associated with the multiple stretching (biaxially orienting) of the solid laminated sheet, whereas the term "unoriented" is employed for the extruded film, although it is noted that even this film contains orientation, compare also col. 3, lines 13-16 and 48-52, as well as 57-58.

It is believed that when the examiner has carefully considered the arguments presented in the previously non-entered amendment with a correct understanding of the instant claim limitations, it will be clear to him that the rejections of record are untenable. Thus, favorable reconsideration and allowance of the instant claims is respectfully solicited.

A check in the amount of \$900.00 is attached to cover the RCE fee, the one month extension fee and the fee for one independent claim over 3.

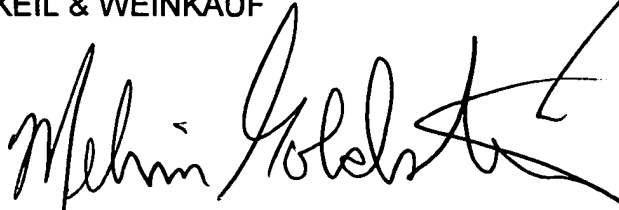
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GREFENSTEIN et al., Serial No. 08/987,775

paper, including Extension of Time fees to Deposit Account No. 11-0345. Please credit any excess fees to such deposit account.

Respectfully submitted,

KEIL & WEINKAUF

A handwritten signature in black ink, appearing to read "Melvin Goldstein", with a long, sweeping horizontal stroke extending to the right.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Cancel claims 33 and 36-38.

Amend claims 24, 25, 27-29 and 35 as follows:

24. (amended) A laminated sheet or film comprising the following (co)extruded layers:

[(1)] a substrate layer comprising - based on the sum of the amounts of the following components A and B and, if used, C and/or D, which totals 100% by weight -

[a] 1 - 99% by weight component A, which is of a graft copolymer of

[a1] 1 - 99% by weight of a particulate graft base A1 comprising the following monomers:

[a11] 80 - 99.99% by weight of at least one C₁₋₈-alkyl ester of acrylic acid as component A11;

[a12] 0.01 -20% by weight of at least one polyfunctional crosslinking monomer as component A12;

[a2] 1 - 99% by weight of a graft A2 comprising the following monomers, based on A2:

[a21] 40 - 100% by weight of units of styrene, a substituted styrene or a (meth)acrylate, or mixtures thereof, as component A21 and

[a22] up to 60% by weight of units of acrylonitrile or methacrylonitrile as component A22;

the graft A2 comprising at least one graft shell and the graft
copolymer having a mean particle size of 50 - 1000 nm[,] ;

[as component A,]

[b] 1 - 99% by weight of component B, which is a copolymer of

[b1] 40 - 100% by weight of units of styrene, a substituted styrene or a
(meth)acrylate, or mixtures thereof, as component B1, and

[b2] up to 60% by weight of acrylonitrile or methacrylonitrile as component B2
[,] ;

[as component B,]

[c] 0 - 80% by weight of component C, which is a polycarbonate [polycarbonates as
component C,] ; and

[d] 0 - 50% by weight of component D, which is a fibrous or particulate [fillers] filler
or mixtures thereof [as component D,] ;

and

[(3)] a transparent top layer of polymethyl methacrylate.

25. (amended) A laminated sheet or film as defined in claim 24, additionally
comprising between the top layer and the substrate layer

[(2)] an (co)extruded interlayer of impact-modified polymethyl methacrylate,
polycarbonate or a molding composition of [component (1)] the substrate layer
as set forth in claim 24 without polycarbonate, if [component (1)] the substrate

layer contains polycarbonate.

27. (amended) A laminated film comprising, in this order, the following

(co)extruded layers:

- [(1')] a substrate layer comprising [a molding compound of component (1)] a member selected from the group consisting of components A and B, and optionally C and D, as set forth in claim 24 [,] ; ABS [,] ; polycarbonate [,] ; polybutylene terephthalate [,] ; polyethylene terephthalate [,] ; polyamide [,] ; polyetherimide [,] ; polyether ketone [,] ; polyphenylene sulfide [,] ; and polyphenylene ether or blends thereof, the substrate layer having a layer thickness of from 90 to 990 μm ; and
- [(3')] a transparent top layer comprising a member selected from the group consisting of: polymethyl methacrylate [,] ; high-impact polymethyl methacrylate [,] ; ABS [,] ; polycarbonate [,] ; polyethylene terephthalate [,] ; styrene-acrylonitrile copolymers [,] ; polyamide [,] ; and polyether sulfone or polysulfone[,] ; the top layer having a layer thickness of from 10 to 100 μm [,] ;
- [it being possible for] the substrate layer [to comprise] comprising special-effect colorants [and comprising them] if the substrate layer and the top layer are composed of polyamide, [and] the overall thickness of the laminated film being from 100 to 1000 μm .

28. (amended) A laminated film as defined in claim 27, additionally comprising

between the top layer and the substrate layer

[(2'')] an (co)extruded interlayer of a member selected from the group consisting of:
polymethyl methacrylate [,] ; high-impact polymethyl methacrylate [,] ; ABS [,] ;
polycarbonate [,] ; polyethylene terephthalate [,] ; styrene-acrylonitrile
copolymers [,] ; polyamide [,] ; polyether sulfone or polysulfone, [which
comprises] the interlayer comprising special-effect colorants and [has] having a
layer thickness of from 50 to 400 µm.

29. (amended) A laminated film as defined in claim 28, additionally comprising,
on the outer surface of the substrate layer,

[(0)] an (co)extruded adhesion layer comprising an adhesion promoter and having a
layer thickness of from 5 to 100 µm.

35. (amended) A laminated sheet or film as defined in claim 24, wherein a
transport protection film is applied to the outside of the top layer [(3)].

Add new claims 39 and 40 as follows:

39. (new) A laminated film comprising the following (co)extruded layers:
a substrate layer comprising - based on the sum of the amounts of the following
components A and B and, if used, C and/or D, which totals 100% by weight -

1 - 99% by weight component A, which is of a graft copolymer of

1 - 99% by weight of a particulate graft base A1 comprising the following
monomers:

80 - 99.99% by weight of at least one C₁₋₈-alkyl ester of acrylic acid
as component A11;

0.01 -20% by weight of at least one polyfunctional crosslinking
monomer as component A12;

1 - 99% by weight of a graft A2 comprising the following monomers,
based on A2:

40 - 100% by weight of units of styrene, a substituted styrene or a
(meth)acrylate, or mixtures thereof, as component A21 and

up to 60% by weight of units of acrylonitrile or methacrylonitrile as
component A22;

the graft A2 comprising at least one graft shell and the graft
copolymer having a mean particle size of 50 - 1000 nm;

1 - 99% by weight of component B, which is a copolymer of

40 - 100% by weight of units of styrene, a substituted styrene or a
(meth)acrylate, or mixtures thereof, as component B1, and

up to 60% by weight of acrylonitrile or methacrylonitrile as component B2;

0 - 80% by weight of component C, which is a polycarbonate; and

0 - 50% by weight of component D, which is a fibrous or particulate filler or
mixtures thereof;

and

a transparent top layer of polymethyl methacrylate.

40. (new) A laminated sheet or film, which is suitable for producing moldings, comprising the following (co)extruded layers:

a substrate layer comprising - based on the sum of the amounts of the following components A and B and, if used, C and/or D, which totals 100% by weight -

1 - 99% by weight component A, which is of a graft copolymer of

1 - 99% by weight of a particulate graft base A1 comprising the following monomers:

80 - 99.99% by weight of at least one C₁₋₈-alkyl ester of acrylic acid as component A11;

0.01 -20% by weight of at least one polyfunctional crosslinking monomer as component A12;

1 - 99% by weight of a graft A2 comprising the following monomers, based on A2:

40 - 100% by weight of units of styrene, a substituted styrene or a (meth)acrylate, or mixtures thereof, as component A21 and

up to 60% by weight of units of acrylonitrile or methacrylonitrile as component A22;

the graft A2 comprising at least one graft shell and the graft copolymer having a mean particle size of 50 - 1000 nm;

1 - 99% by weight of component B, which is a copolymer of
40 - 100% by weight of units of styrene, a substituted styrene or a
(meth)acrylate, or mixtures thereof, as component B1, and
up to 60% by weight of acrylonitrile or methacrylonitrile as component B2;
0 - 80% by weight of component C, which is a polycarbonate; and
0 - 50% by weight of component D, which is a fibrous or particulate filler or
mixtures thereof;

and

a transparent top layer of polymethyl methacrylate.

FULL SET OF CLAIMS

24. (amended) A laminated sheet or film comprising the following (co)extruded layers:

a substrate layer comprising - based on the sum of the amounts of the following components A and B and, if used, C and/or D, which totals 100% by weight -

1 - 99% by weight component A, which is of a graft copolymer of

1 - 99% by weight of a particulate graft base A1 comprising the following monomers:

80 - 99.99% by weight of at least one C₁₋₈-alkyl ester of acrylic acid as component A11;

0.01 -20% by weight of at least one polyfunctional crosslinking monomer as component A12;

1 - 99% by weight of a graft A2 comprising the following monomers, based on A2:

40 - 100% by weight of units of styrene, a substituted styrene or a (meth)acrylate, or mixtures thereof, as component A21 and

up to 60% by weight of units of acrylonitrile or methacrylonitrile as component A22;

the graft A2 comprising at least one graft shell and the graft copolymer having a mean particle size of 50 - 1000 nm[.];

- 1 - 99% by weight of component B, which is a copolymer of
 - 40 - 100% by weight of units of styrene, a substituted styrene or a (meth)acrylate, or mixtures thereof, as component B1, and
 - up to 60% by weight of acrylonitrile or methacrylonitrile as component B2;
- 0 - 80% by weight of component C, which is a polycarbonate; and
- 0 - 50% by weight of component D, which is a fibrous or particulate filler or mixtures thereof;

and

a transparent top layer of polymethyl methacrylate.

25. (amended) A laminated sheet or film as defined in claim 24, additionally comprising between the top layer and the substrate layer
- an (co)extruded interlayer of impact-modified polymethyl methacrylate, polycarbonate or a molding composition of the substrate layer as set forth in claim 24 without polycarbonate, if the substrate layer contains polycarbonate.

26. A laminated sheet or film as defined in claim 24, having an overall thickness of from 100 μm to 10 mm.

27. (amended) A laminated film comprising, in this order, the following (co)extruded layers:

- a substrate layer comprising a member selected from the group consisting of components A and B, and optionally C and D, as set forth in claim 24; ABS;

polycarbonate; polybutylene terephthalate; polyethylene terephthalate; polyamide; polyetherimide; polyether ketone; polyphenylene sulfide; and polyphenylene ether or blends thereof, the substrate layer having a layer thickness of from 90 to 990 μm ; and

a transparent top layer comprising a member selected from the group consisting of: polymethyl methacrylate; high-impact polymethyl methacrylate; ABS; polycarbonate; polyethylene terephthalate; styrene-acrylonitrile copolymers; polyamide; and polyether sulfone or polysulfone; the top layer having a layer thickness of from 10 to 100 μm ;

the substrate layer comprising special-effect colorants if the substrate layer and the top layer are composed of polyamide, the overall thickness of the laminated film being from 100 to 1000 μm .

28. (amended) A laminated film as defined in claim 27, additionally comprising between the top layer and the substrate layer

an (co)extruded interlayer of a member selected from the group consisting of: polymethyl methacrylate; high-impact polymethyl methacrylate; ABS; polycarbonate; polyethylene terephthalate; styrene-acrylonitrile copolymers; polyamide; polyether sulfone or polysulfone, the interlayer comprising special-effect colorants and having a layer thickness of from 50 to 400 μm .

29. (amended) A laminated film as defined in claim 28, additionally comprising,

on the outer surface of the substrate layer,

an (co)extruded adhesion layer comprising an adhesion promoter and having a layer thickness of from 5 to 100 μm .

30. A laminated sheet or film as defined in claim 24, wherein the ratio of the MFI values of the individual components of the laminated sheet or film is not more than 3:1.

31. A molding comprising a shaped laminated sheet as defined in claim 24.

32. A molding comprising a shaped laminated sheet as defined in claim 25.

34. A molding as defined in claim 31 in the form of an automotive exterior bodywork component.

35. (amended) A laminated sheet or film as defined in claim 24, wherein a transport protection film is applied to the outside of the top layer.

39. (new) A laminated film comprising the following (co)extruded layers:
a substrate layer comprising - based on the sum of the amounts of the following components A and B and, if used, C and/or D, which totals 100% by weight -

1 - 99% by weight component A, which is of a graft copolymer of

1 - 99% by weight of a particulate graft base A1 comprising the following monomers:

80 - 99.99% by weight of at least one C_{1-8} -alkyl ester of acrylic acid as component A11;

0.01 -20% by weight of at least one polyfunctional crosslinking monomer as component A12;

1 - 99% by weight of a graft A2 comprising the following monomers, based on A2:

40 - 100% by weight of units of styrene, a substituted styrene or a (meth)acrylate, or mixtures thereof, as component A21 and

up to 60% by weight of units of acrylonitrile or methacrylonitrile as component A22;

the graft A2 comprising at least one graft shell and the graft copolymer having a mean particle size of 50 - 1000 nm;

1 - 99% by weight of component B, which is a copolymer of

40 - 100% by weight of units of styrene, a substituted styrene or a (meth)acrylate, or mixtures thereof, as component B1, and

up to 60% by weight of acrylonitrile or methacrylonitrile as component B2;

0 - 80% by weight of component C, which is a polycarbonate; and

0 - 50% by weight of component D, which is a fibrous or particulate filler or mixtures thereof;

and

a transparent top layer of polymethyl methacrylate.

40. (new) A laminated sheet or film, which is suitable for producing moldings,

comprising the following (co)extruded layers:

a substrate layer comprising - based on the sum of the amounts of the following components A and B and, if used, C and/or D, which totals 100% by weight -

1 - 99% by weight component A, which is of a graft copolymer of

1 - 99% by weight of a particulate graft base A1 comprising the following monomers:

80 - 99.99% by weight of at least one C₁₋₈-alkyl ester of acrylic acid as component A11;

0.01 -20% by weight of at least one polyfunctional crosslinking monomer as component A12;

1 - 99% by weight of a graft A2 comprising the following monomers, based on A2:

40 - 100% by weight of units of styrene, a substituted styrene or a (meth)acrylate, or mixtures thereof, as component A21 and

up to 60% by weight of units of acrylonitrile or methacrylonitrile as component A22;

the graft A2 comprising at least one graft shell and the graft copolymer having a mean particle size of 50 - 1000 nm;

1 - 99% by weight of component B, which is a copolymer of

40 - 100% by weight of units of styrene, a substituted styrene or a

(meth)acrylate, or mixtures thereof, as component B1, and

up to 60% by weight of acrylonitrile or methacrylonitrile as component B2;

0 - 80% by weight of component C, which is a polycarbonate; and

0 - 50% by weight of component D, which is a fibrous or particulate filler or mixtures thereof;

and

a transparent top layer of polymethyl methacrylate.

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; colon, col(o)- or coli-; duode-
duoden(o)-; jejunum, jejun(o)-, il-
ili(o)- or ile(o)-; appendix, vermi-
appendix or process, append(o)- or
ndic(o)-; rectum, rect(o)-, proct(o)-
octi-; anus 265.6, ano-.

ology, enterography, splanchnology;
nal medicine.
ss internalize, put in, keep within;
se, embed, surround, contain, com-
include, enfold.

interior, internal, inner, inside, in-
l, intestine; innermost, inmost, inti-
e; intrinsic 5.6; deep 209.10; central
11; indoor; en- or em-, end(o)-, ent-
eso-, infra-, in- or im- or il- or ir-,
r-, intra-, ob-.

nd, interior, up-country; hinterland
8; midland, mediterranean; inshore.
amarginal, intramural, intramundane,
amontane, intraterritorial, intracoast-
intragroupal.

eral, splanchnic; abdominal, gastric
5; pyloric; intestinal, enteric; colonic,
ic; cecal, duodenal, ileac, jejunal,
sogastric, appendical, rectal, anal; car-
c, coronary.

vs internally, inwardly, interiorly, inly,
imately, deeply, profoundly, under the
face; intrinsically 5.9; centrally 226.16.

inside, within; herein, therein, where-

ward, inwards, inwardly, withinward,
thinwards; inland, inshore.

doors, indoor, withindoors.

EPS in, into; within, at, inside, inside

; in the limits of; to the heart or core

226. CENTRALITY

OUNS centrality, centralness, middle-
ess, central or middle or mid position;
entricity, centrality; concentricity; cen-
ripetence, centripetalism.

enter, centro(o)- or centri-, middle 69,
heart, core, nucleus, nucle(o)-, nuclei-
ernel; pith, metr(o)-, marrow, myel(o)-,
nedulla; nub, hub, nave, axis, pivot; na-
vel, umbilicus, omphalos; bull's-eye; dead
center; center of action or area or buoy-
ancy or displacement or curvature or ef-
fort or figure or flotation or inversion or
origin or oscillation or ossification or per-
cussion or pressure or projection or simil-
itude or suspension or symmetry or vol-
ume; metacenter; epicenter, centrum;
storm center; center of gravity, center of

mass or inertia, centroid; "the still point
of the turning world" [T. S. Eliot].

3 [biol terms] central body, centriole, cen-
trosome, centrosphere.

4 focus, focal point, prime focus, point of
convergence; center of interest or atten-
tion, focus of attention, center of con-
sciousness; center of attraction, cynosure;
polestar, lodestar; magnet.

5 nerve center, ganglion, center of activity,
vital center.

6 headquarters, HQ, central station, cen-
tral office, main office, central adminis-
tration, seat, base, base of operations,
center of authority; general headquarters,
GHQ, command post, CP, company
headquarters.

7 metropolis, capital; urban center, art cen-
ter, medical center, shopping center,
shipping center, railroad center, garment
center, manufacturing center, tourist cen-
ter, trade center, etc.

8 centralization, centering; focalization, fo-
cusing; convergence 298; concentration,
centralization, pooling; centralism.

9 VERBS centralize, center, middle; center
round, center on or in.

10 focus, focalize, come to a point or focus,
bring into focus; concentrate, concentrat-
ize, concenter; converge 298.2.

11 ADJS central, centric, middle 69.4; center-
most, middlemost, midmost; centralized,
concentrated; umbilical, omphalic; axial,
pivotal, key; centroidal; centrosymmetric;
geocentric.

12 nuclear, nucleal, nucleary, nucleate.

13 focal, confocal; converging; centrolineal,
centripetal.

14 concentric; homocentric; coaxial, coaxal.

15 ADVS centrally, in the center or middle
of, at the heart of.

227. LAYER

1 NOUNS layer, -cline, thickness; level, tier,
stage, story, floor, gallery, step, ledge,
deck; stratum, strati-, seam, couche [Fr],
belt, band, bed, course, measures; zone;
shelf; overlayer, superstratum, overstory,
topsoil; underlayer, substratum, under-
stratum, understory; floor, bedding.

2 lamina, lamella, lamin(o)- or lamini-,
lamell(i)-; sheet, leaf, feuille [Fr], foil,
pallio-; wafer, disk; plate, plating; cover-
ing 228, coat, coating, veneer, film, pa-
tina, scum, membrane, pellicle, peel,
skin; slice, cut, rasher, collop; slab, plank,
deal [Brit], slat, tablet, table, plac(o)-,
pinac(o)- or pinak-; panel, pane; fold,

lap, ply, plait; laminated glass,
safety glass; laminated wood, plywood.

3 flake, flock, floccule, flocculus; lepid(o)-,
-lepis, phalid(o)-, squam(o)-; scale, scurf,
dandruff; chip; shaving, paring.

4 stratification, lamination, lamellation; fo-
liation; delamination, exfoliation; des-
quamation, furfuration; flakiness, scali-
ness.

5 VERBS layer, lay down, lay up, stratify, ar-
range in layers or levels or strata or tiers,
laminate; flake, scale; delaminate, des-
quamate, exfoliate.

6 ADJS layered, in layers; laminated, lami-
nate, laminous; lamellated, lamellate, la-
mellar, lamelliform; two-ply, three-ply,
etc.; stratified, stratiform; foliated, folia-
ceous, leaflike, leafy; spathic, spathose;
filmy, scummy; membranous.

7 flaky, flocculent; scaly, scurfy, squamous,
lentiginous, furfureaceous, lepidote; scab-
by, scabious, scabrous, asperous.

228. COVERING

1 NOUNS (act of covering) covering, cover-
age, obduction; coating, cloaking; screen-
ing, shielding, hiding, curtaining, veiling,
clouding, obscuring, masking, mantling,
shrouding, blanketing; blocking, blotting
out, eclipse, eclipsing, occultation; wrap-
ping, enwrapping, enwrapment, sheath-
ing, envelopment; overlaying, overspread-
ing, laying on or over, superimposition,
superposition; superincumbence; uphol-
stering, upholstery; plasterwork, stucco-
work, cementwork, pargeting; incrusta-
tion.

2 cover 228.38, covering, coverage, covert,
coverture, housing, hood, cowl, cowl,ing,
shelter; screen, shroud, shield, veil, pall,
mantle, curtain, hanging, drape, drapery;
coat, cloak, mask, guise; vestment 23.1;
blanket.

3 integument, tegument, tegmen, tegmen-
tum.

4 overlayer, overlay; appliqué; lap, overlap,
overlapping, imbrication; flap, fly, tent-
fly.

5 cover, lid, top, cap; operculum; stopper
266.4.

6 roof 228.39, roofing, roofage, top, house-
top, rooftop; roof-deck, roof garden,
penthouse; roofpole, ridgepole, roof-tree;
shingles, slates, tiles; eaves; ceiling, pla-
fond [Fr], overhead; skylight, lantern;
widow's walk or captain's walk.

7 umbrella, gamp or brolly [both Brit infor-

mal], bun
parasol, b-

8 tent 228.4
top, big t-

9 rug, carpe
doormat,
to-wall c-
cloth, gro-
duckboard

10 blanket, s-
spread, re-
[Brit]; la-
counterpa-

comforter
quilt; bed
bed linen
ted sheet
low slip, c-

11 horsecloth
housing; s-

12 coating, c-
pellicle, f-
nish, enar-

13 plating, p-
gold plate
anodized
trocoating

14 crust, inc-
shell; stal-
char.

15 shell 228.
test, test-
elytr(o)-
mail, shie-
-stegite,
protective

16 hull, she-
shuck; co-
skin 229, l-

17 case, casin-
ing, cole(o)-

18 wrapper,
binder, b-
velope, e-
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Ullmann's Encyclopedia of Industrial Chemistry

Fifth, Completely Revised Edition

Volume A 11:

Fibers, 5. Synthetic Inorganic, to Formaldehyde

Executive Editor: Wolfgang Gerhartz

Senior Editor: Y. Stephen Yamamoto

Editors: Barbara Elvers, James F. Rounsaville,
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Content

Fibers, 5.
Fibers, 6.
Films ...
Fire Extir
Flame Re
Flavors a
Flocculan
Floor Co
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Film Depo
Filters, Op
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| | |
|-------|--|
| PA | polyamide |
| PBT | poly(butylene terephthalate) |
| PC | polycarbonate |
| PCTFE | polychlorotrifluoroethylene |
| PEI | polyetherimide |
| PEK | polyetherketone |
| PEN | poly(ethylene-2,6-naphthalene dicarboxylate) |
| PES | polyethersulfone |
| PETP | poly(ethylene terephthalate) |
| PFA | perfluoroalkoxy copolymer |
| PI | polyimide |
| PMMA | poly(methyl methacrylate) |
| PMP | poly(4-methyl-1-pentene) |
| PP | polypropylene |
| PPS | poly(phenylene sulfide) |
| PS | polystyrene |
| PSU | polysulfone |
| PTFE | polytetrafluoroethylene |
| PVA | poly(vinyl alcohol) |
| PVC | poly(vinyl chloride) |
| PVDC | poly(vinylidene chloride) |
| PVDF | poly(vinylidene fluoride) |
| PVF | poly(vinyl fluoride) |
| TD | transverse direction |

1. Introduction

The term *film* is applied to thin materials present in a continuous planar form, which are at the same time self-supporting and flexible. A film may consist of one or more layers, usually of differing composition. The term generally encompasses both metallic and polymeric substances, which may be either homogeneous or made heterogeneous by the presence of incompatible additives or blending components. In this article, a film is assumed to be a polymeric material which can be wound into a roll. Film thicknesses range from 0.5 μm to ca. 1 mm.

The characteristics of a film are determined primarily by the raw materials employed, but they are additionally affected by processing methods, modification, and converting (e.g., stretching, coating and lamination).

Film materials are of considerable economic importance. In 1986, the annual worldwide consumption of film for packaging and technical applications was ca. 11×10^6 t. Figures for the worldwide consumption of the more important film materials are listed in Table 1.

Films are used as flexible packaging materials, as insulation for electrical conductors, as

Table 1. Worldwide consumption of some of the most important types of film in 1986*

| Material | Consumption, 10^6 t |
|---|-----------------------|
| Low-density polyethylene (LDPE) | 8.00 |
| Polypropylene, biaxially oriented (BOPP) | 0.55 |
| Poly(vinyl chloride) (PVC), rigid and plasticized | 1.42 |
| Poly(ethylene terephthalate) (PETP), biaxially oriented | 0.55 |
| Cellophane | 0.26 |

* Hoechst marketing research, Kalle Works, Federal Republic of Germany.

protective layers on sensitive surfaces, and as windable base materials for subsequent application of magnetic coatings, electrically conducting, and light-sensitive layers as well as printing inks. Multitudes of film and sheet types have been developed to meet the increasing demands of these applications. These products provide a broad spectrum of mechanical, optical, and electrical properties, as well as various degrees of permeability and stability to temperature and aggressive media.

Historical Aspects [1]. Polymeric films were first developed at the end of the 19th century, when cellulose nitrate was introduced as a base material for photographic emulsions. Other cellulose-based films followed, the most important of which were derived from cellulose acetate and cellulose hydrate. Cellulose triacetate films quickly replaced the highly flammable cellulose nitrate films in the photographic industry; cellulose hydrate films (cellophanes) became important packaging materials, maintaining their dominance until polyolefin films were introduced in the 1950s. Cellophane coated with cellulose nitrate or poly(vinylidene chloride) also played a key role in this respect due to its low permeability to water vapor and oxygen, coupled with desirable sealing properties.

All cellulose-based films are prepared from polymer solutions, however the subsequent introduction of totally synthetic polymers has led to new film production methods, as well as new types of films with unique properties. These developments have been encouraged by the close working relationship between fiber and film producers, particularly in terms of polymer compositions and processing technology.

Important milestones in the development of films included the introduction of

- 1) poly(vinyl chloride) films in the late 1930s
- 2) low-density polyethylene films in the late 1940s
- 3) biaxially oriented polyester and polypropylene films in the 1950s

Parallel and subsequent to these developments, a series of specialty films has emerged. These films are distinguished either by high mechanical or thermal stability, or by special properties such as impermeability to oxygen, advantageous electrical characteristics, or resistance to chemical attack.

2. Production

General processes for the production of films from both monomers and polymers are based on two basic methods:

- 1) solution
- 2) thermoplastic

The method of production has a significant influence on the behavior of the film with respect to certain characteristics, which are decisive for its application.

For solution films, the first step is the dissolution of the polymer in a suitable solvent.

Thermoplastic films are produced by the extrusion of a molten polymer through a die, followed by a rapid cooling process to solidify the film.

The latter method is particularly important for the production of films with specific mechanical and electrical properties.

2.1. Solution

Solution films are produced by the casting of a polymer solution onto a moving substrate. The solvent then evaporates, leaving a solid film. This method is suitable for a wide range of polymers and solvents, and can produce films with varying thicknesses and properties.

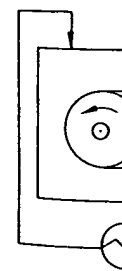


Figure 1. Film production process:
a) Agitator with blades
b) Final dry film